Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of the Environment, Transport, Energy and Communications DETEC

Federal Office for the Environment
Noise Abatement and NIR Division

EMPA
Materials Science & Technology

sonRAIL
Lärmberechnung Eisenbahn

sonRAIL: FOEN / EMPA web tool for calculating railway noise

Version 1.1.2, December 9th, 2015

Contents

1 Introduction 3
2 Definitions and system requirements 3
2.1 Definitions 3
2.2 System requirements 3
3 Logging in 4
4 Vehicle emissions 5
4.1 Stored vehicle settings 7
4.2 Input parameters 7
4.2.1 Roughness of rails 7
4.2.2 Superstructure types 9
4.2.3 Curvature (metres) 10
4.2.4 Types of bridges 10
4.2.5 Category 10
4.2.6 Series 11
4.2.7 Length 11
4.2.8 Number of axles 11
4.2.9 Wheel flats 11
4.2.10 Speed 11
4.3 Series details 11
4.4 Results (graph) 12
4.5 Results (table) 13
5 Railway route emissions 13
5.1 List calculations / templates for list calculations 14
5.2 Stored route settings 15
5.3 Railway route parameters 15
5.4 Metadata 15
5.5 Results / overview 16
5.6 Train composition 17
5.7 Train details 18
6 Administration 19
6.1 Manage templates 19
6.2 Download templates 19
7 Appendix A – Indication of uncertainty factors in sonRAIL 20

1 Introduction

“sonRAIL” is a web application developed by the FOEN and EMPA (Swiss Federal Laboratories for Materials Science and Technology) that can be used for calculating emissions from individual railway vehicles and entire routes of railway. It replaces the previous Microsoft Excel tool for calculating railway noise levels.

The application is hosted at the following Internet address: https://sonrail.empa.ch/. To access the calculation functions, authorised users are required to log in to the above homepage via a link that will be sent to them upon request.

2 Definitions and system requirements

2.1 Definitions

Leq	Equivalent continuous sound level in db(A)
LpAeq,T	A-weighted energy-equivalent continuous sound level at a distance of 7.5 meters from the centre of the tracks during pass-by time T. LpAeq,T . LpAeq,T (0m), …, LpAeq,T (4m) correspond to the noise emissions at the respective source heights, LpAeq,T (roll) corresponds to the rolling noise emissions and LpAeq,T (tot) corresponds to the total noise.
LwA	On the web page "vehicle calculation" the LwA represents the A-weighted average sound power level of the vehicle. On the web page "route calculation" the LWA represents the A-weighted average sound power level of a route section of 1 m length for the periods day or night according to the Swiss Federal Noise Abatement Ordinance. LwA (0m), …, LwA (4m) correspond to the noise emissions at the respective source heights, LwA (roll) corresponds to the rolling noise emissions and LwA (tot) corresponds to the total noise.
Lr	Applicable emissions level (Lr) for daytime and nighttime in accordance with Annex 3 and 4 of the Swiss Federal Noise Abatement Ordinance.
K1 adjustment	K1 level adjustment for daytime and nighttime in accordance with Annexes 3 and 4 of the Swiss Federal Noise Abatement Ordinance.
Uncertainties	The potential uncertainty of a resultant value is indicated with the aid of a colour scale. For details, please refer to section 7.
Train composition	A train composition comprises 1-n train details.
Train detail	A train detail describes a locomotive/wagon of a train.

2.2 System requirements

In order to use the application, Internet access and a browser are required.
The sonRAIL web tool was tested for the following browsers:
- Internet Explorer 10.0.6
- Google Chrome 27.0.1453.116
- Mozilla Firefox 22.0

JavaScript has to be activated in all browsers.
In addition, Adobe Flash Player has to be installed in Google Chrome and Mozilla Firefox.

For the processing of results of calculations we recommend using Microsoft Excel.

3 Logging in

Enter https://sonrail.empa.ch/ in your browser. The following window will then appear on screen:

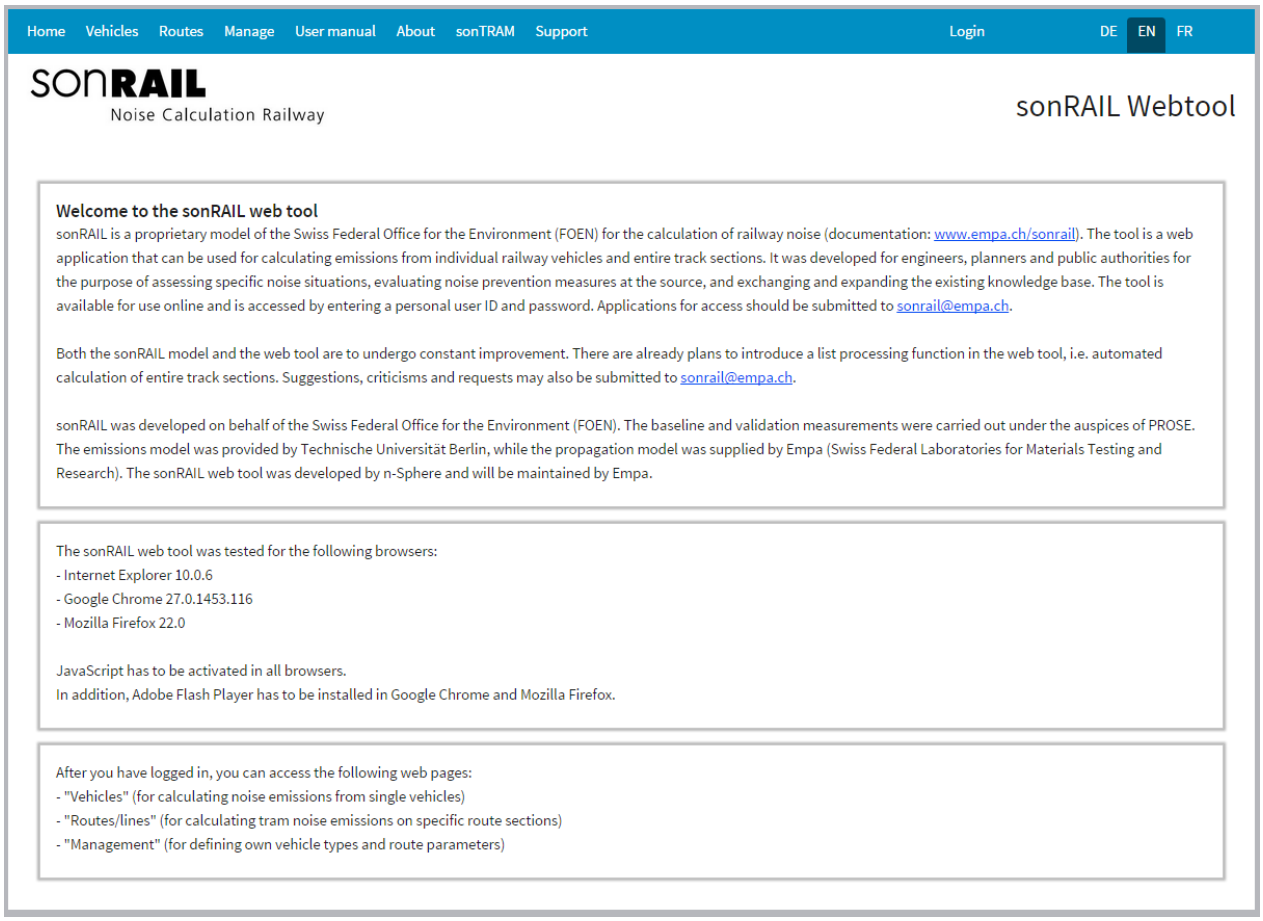

Home
Vehicles
Routes
Manage
User manual
About
sonTRAM
Support
Login
DE
EN
FR
sonRAIL
Noise Calculation Railway
sonRAIL Webtool
Welcome to the sonRAIL web tool
sonRAIL is a proprietary model of the Swiss Federal Office for the Environment (FOEN) for the calculation of railway noise (documentation: www.empa.ch/sonrail). The tool is a web application that can be used for calculating emissions from individual railway vehicles and entire track sections. It was developed for engineers, planners and public authorities for the purpose of assessing specific noise situations, evaluating noise prevention measures at the source, and exchanging and expanding the existing knowledge base. The tool is available for use online and is accessed by entering a personal user ID and password. Applications for access should be submitted to sonrail@empa.ch.
Both the sonRAIL model and the web tool are to undergo constant improvement. There are already plans to introduce a list processing function in the web tool, i.e. automated calculation of entire track sections. Suggestions, criticisms and requests may also be submitted to sonrail@empa.ch.
sonRAIL was developed on behalf of the Swiss Federal Office for the Environment (FOEN). The baseline and validation measurements were carried out under the auspices of PROSE. The emissions model was provided by Technische Universität Berlin, while the propagation model was supplied by Empa (Swiss Federal Laboratories for Materials Testing and Research). The sonRAIL web tool was developed by n-Sphere and will be maintained by Empa.
The sonRAIL web tool was tested for the following browsers:
- Internet Explorer 10.0.6
- Google Chrome 27.0.1453.116
- Mozilla Firefox 22.0
JavaScript has to be activated in all browsers.
In addition, Adobe Flash Player has to be installed in Google Chrome and Mozilla Firefox.
After you have logged in, you can access the following web pages:
- "Vehicles" (for calculating noise emissions from single vehicles)
- "Routes/lines" (for calculating tram noise emissions on specific route sections)
- "Management" (for defining own vehicle types and route parameters)

Figure 1: "sonRAIL" login window

Clicking on Login or one of the protected menu items (Vehicles, Routes and Administration) opens the following login dialogue:

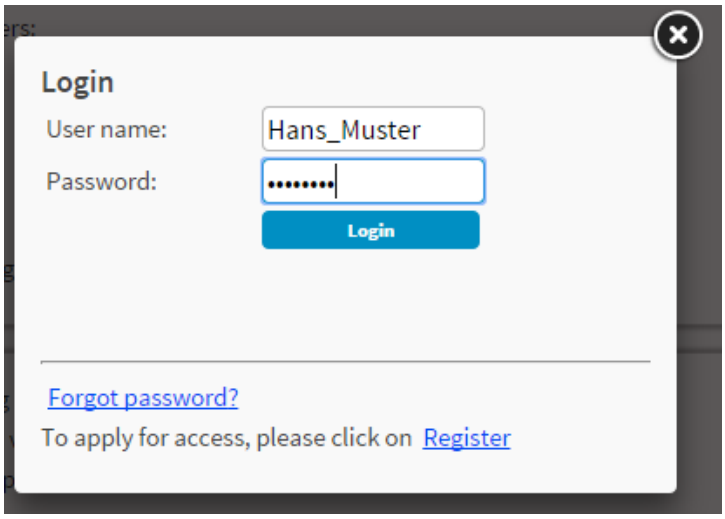


Figure 2: Login page – status after you have logged in

Enter the provided login data in the user name and password fields. If you have forgotten your password, you can reset it by clicking on "Forgot password?". If you have not yet received your login details, click on

“Register” to send a request to the administrator of the web tool using your standard e-mail application. After you have successfully logged in, you will have access to all the functions of the web tool.

After you have logged in, your user name will be displayed in the menu.
If you move the mouse over your user name, you will see two options: one for changing your password, and the other for logging out.

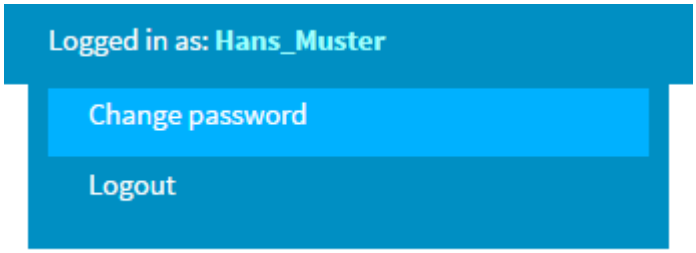
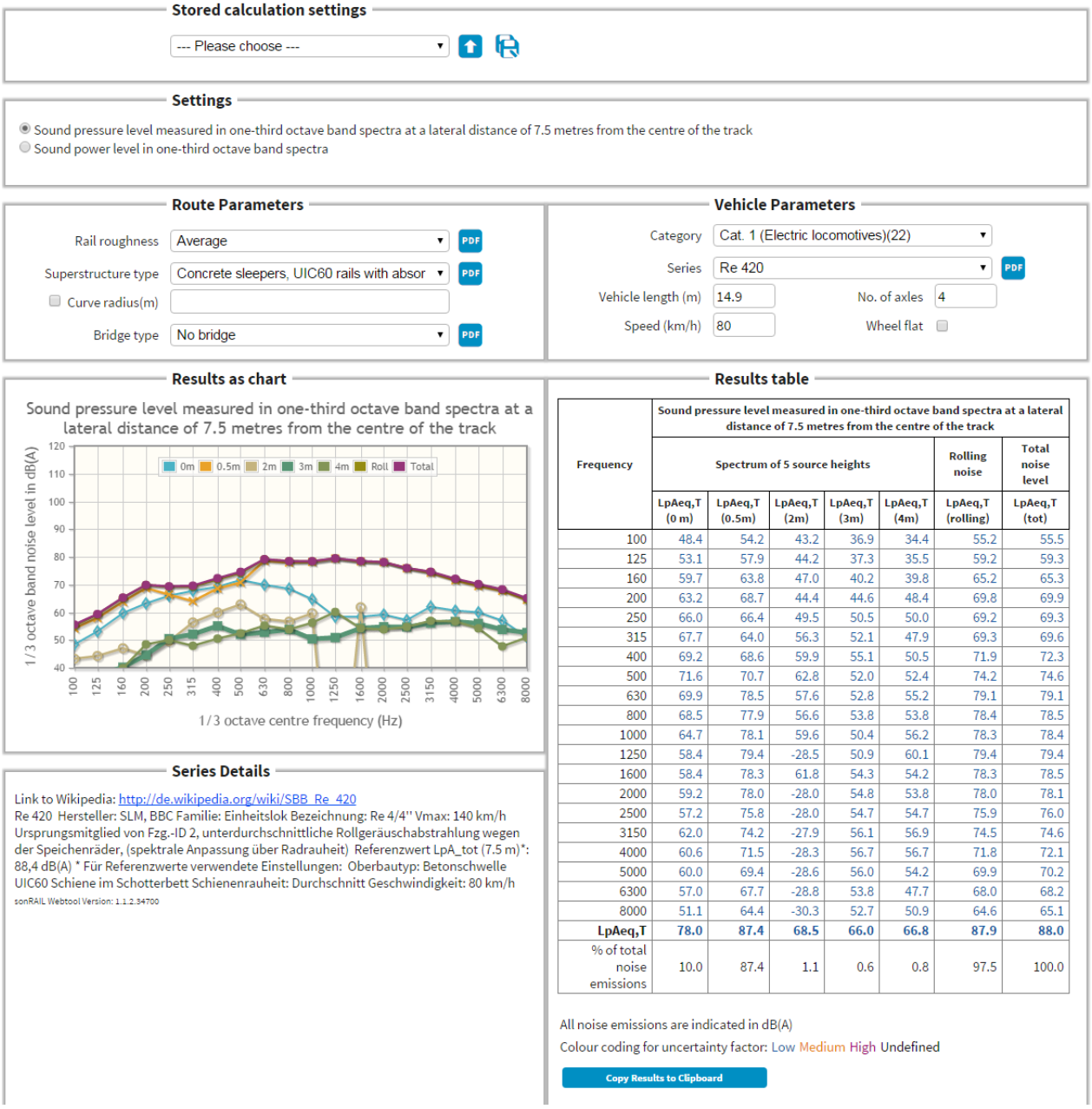


Figure 3: Changing your password / logging out

4 Vehicle emissions

After you have logged in you can carry out emission calculations for individual vehicles by selecting the “Vehicles” tab.

The following page will now appear on screen:


Stored calculation settings
--- Please choose ---
Settings
Sound pressure level measured in one-third octave band spectra at a lateral distance of 7.5 metres from the centre of the track
Sound power level in one-third octave band spectra
Route Parameters
Rail roughness
Average
Superstructure type
Concrete sleepers, UIC60 rails with absor
Curve radius(m)
Bridge type
No bridge
Vehicle Parameters
Category
Cat. 1 (Electric locomotives)(22)
Series
Re 420
Vehicle length (m)
14.9
No. of axles
4
Speed (km/h)
80
Wheel flat
Results as chart
Sound pressure level measured in one-third octave band spectra at a lateral distance of 7.5 metres from the centre of the track
0m 0.5m 2m 3m 4m Roll Total
1/3 octave band noise level in dB(A)
1/3 octave centre frequency (Hz)
Series Details
Link to Wikipedia: http://de.wikipedia.org/wiki/SBB_Re_420
Re 420 Hersteller: SLM, BBC Familie: Einheitslok Bezeichnung: Re 4/4'' Vmax: 140 km/h Ursprungsmitglied von Fzg.-ID 2, unterdurchschnittliche Rollgeräuschabstrahlung wegen der Speichenräder, (spektrale Anpassung über Radrauheit) Referenzwert LpA_tot (7.5 m)*: 88,4 dB(A) * Für Referenzwerte verwendete Einstellungen: Oberbautyp: Betonschwelle UIC60 Schiene im Schotterbett Schienenrauheit: Durchschnitt Geschwindigkeit: 80 km/h
sonRAIL Webtool Version: 1.1.2.34700
Results table

Frequency	Sound pressure level measured in one-third octave band spectra at a lateral distance of 7.5 metres from the centre of the track						
	Spectrum of 5 source heights					Rolling noise	Total noise level
	LpAeq,T (0 m)	LpAeq,T (0.5m)	LpAeq,T (2m)	LpAeq,T (3m)	LpAeq,T (4m)	LpAeq,T (rolling)	LpAeq,T (tot)
100	48.4	54.2	43.2	36.9	34.4	55.2	55.5
125	53.1	57.9	44.2	37.3	35.5	59.2	59.3
160	59.7	63.8	47.0	40.2	39.8	65.2	65.3
200	63.2	68.7	44.4	44.6	48.4	69.8	69.9
250	66.0	66.4	49.5	50.5	50.0	69.2	69.3
315	67.7	64.0	56.3	52.1	47.9	69.3	69.6
400	69.2	68.6	59.9	55.1	50.5	71.9	72.3
500	71.6	70.7	62.8	52.0	52.4	74.2	74.6
630	69.9	78.5	57.6	52.8	55.2	79.1	79.1
800	68.5	77.9	56.6	53.8	53.8	78.4	78.5
1000	64.7	78.1	59.6	50.4	56.2	78.3	78.4
1250	58.4	79.4	-28.5	50.9	60.1	79.4	79.4
1600	58.4	78.3	61.8	54.3	54.2	78.3	78.5
2000	59.2	78.0	-28.0	54.8	53.8	78.0	78.1
2500	57.2	75.8	-28.0	54.7	54.7	75.9	76.0
3150	62.0	74.2	-27.9	56.1	56.9	74.5	74.6
4000	60.6	71.5	-28.3	56.7	56.7	71.8	72.1
5000	60.0	69.4	-28.6	56.0	54.2	69.9	70.2
6300	57.0	67.7	-28.8	53.8	47.7	68.0	68.2
8000	51.1	64.4	-30.3	52.7	50.9	64.6	65.1
LpAeq,T	**78.0**	**87.4**	**68.5**	**66.0**	**66.8**	**87.9**	**88.0**
% of total noise emissions	10.0	87.4	1.1	0.6	0.8	97.5	100.0

All noise emissions are indicated in dB(A)

Colour coding for uncertainty factor: Low Medium High Undefined

Copy Results to Clipboard

Figure 4: Overview of the "Vehicles" page

This page is structured so that you can manage your personal vehicle calculations in the upper section, select the route parameters and vehicle characteristics in the section directly below it, and view the results of the calculation in the lower section in the form of a graph and a table, together with a description of the selected train details.

The calculation is automatically initiated as soon as all the necessary parameters have been entered. Please refer to sections 4.2, 4.4 and 4.5. for more detailed information about input parameters and results.

4.1 Stored vehicle settings

This section contains functions for managing personal vehicle calculations. The number of available functions depends on whether a stored calculation has been selected.

Figure 5: Management of vehicle settings

The list contains stored personal vehicle settings that are not visible for other users. New settings can be created, downloaded or uploaded, or deleted via the icons on the right.

With this icon, settings and results can be downloaded in Excel format.

This icon is for uploading settings saved in Excel format. The designation of the settings is the same as the name of the Excel file.

Use this icon for overwriting currently opened settings.

This icon is for saving current settings under a new name.
When you click on it, the following dialogue will appear.

After you have entered a name, please confirm it by clicking again on . To abort the process, click on "Cancel".

Select this icon if you want to delete saved settings.

4.2 Input parameters

The input parameters for calculation are defined in the top left-hand section of the window. The data are entered via a selection list or a text box, depending on the type of parameter. Optional parameters are indicated in the form of a checkbox on the left. These parameters are only included in the calculation if the checkbox has been activated.

> *If an entry is made in a text box that cannot be interpreted, the field concerned will be displayed in red and you will not be able to start the calculation.*

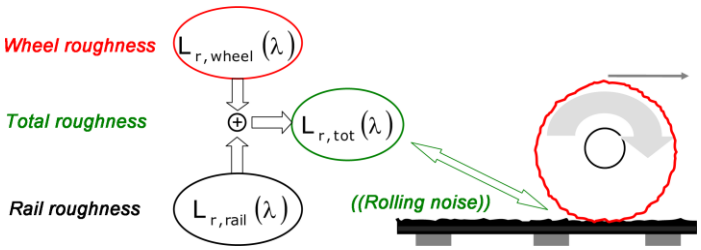
A detailed description is available for some parameters, and this can be viewed in a new browser tab by clicking on the PDF icon to the right of the parameter concerned.

For the sake of clarity, the input parameters have been separated into two groups (Routes and Vehicles). The individual parameters are described below.

> *A list of individual values has not been included, since these can be adapted dynamically and can therefore be modified at any time. Descriptions of currently selectable values can be viewed by clicking on the corresponding PDF icon.*

4.2.1 Roughness of rails

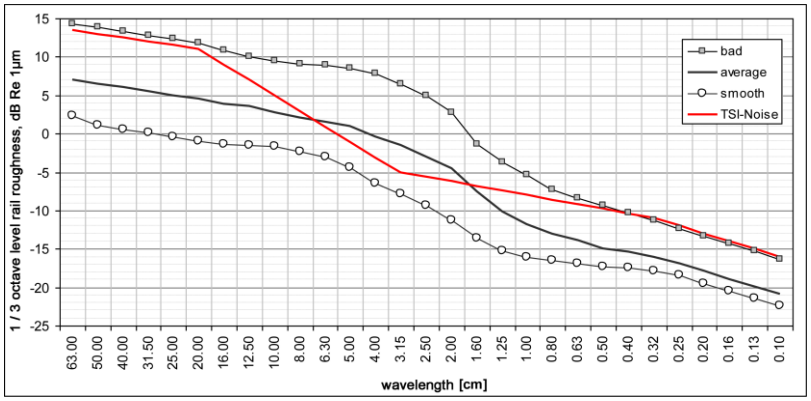
Rolling noise is caused by unevenness of the tread surfaces of the rails and wheels. For noise measurement purposes, surface roughness is understood to be surface waviness in a wavelength range of between 0.1 and 63 centimetres. The amplitude is indicated in dB, where 0 dB corresponds to an amplitude of 1 µm. The level of the mechanical excitation or rolling noise is proportional to the level of the energetic total roughness of rail and wheel. The total roughness is determined by the object with a high degree of roughness, i.e. wheels with a rough surface (for example, those fitted with grey cast iron brakes) on smooth rails and wheels with a smooth surface (for example, those fitted with disc brakes) on rough rails produce the same level of total roughness.



$$L_r = 20 \log \frac{\tilde{r}}{r_0} \quad \text{with} \quad r_0 = 1 \mu m$$

The average levels of roughness in sonRAIL were measured in field tests and are compatible with TWINS calculations. The following four rail roughness classifications have been defined in sonRAIL:

- Rough rail
- Average: medium roughness on Swiss transit routes
- Smooth rail
- Reference track: TSI noise



Rail roughness is a mandatory parameter for noise calculation.

4.2.2 Superstructure types

The rolling noise of moving railway vehicles depends partly on mechanical excitation due to wheel and rail roughness and partly to the transmission properties (absorption) of the involved components. The noise transmission properties of superstructures depend on the degree of noise produced by the components (rails and sleepers) and on the structural damping properties of the rails (track decay rate). Noise emissions from the switches of the relevant type of superstructure are also determined with the aid of a corresponding transfer function. In sonRAIL, the influence of a given type of superstructure is depicted as a specific transfer function in the form of a one-third octave band between 100 and 8,000 Hz.
To date, the effect of rail dampers has only been determined for the superstructure type with concrete sleepers and UIC60 rails in a ballast bed. Therefore an “absorber” transfer function has been included for such calculations.

In order to obtain an impression of the noise emissions of the various superstructure types, the differences in the pass-by noise level as compared to a vehicle with smooth wheels travelling at 80 km/h on a concrete sleeper track with UIC60 rails in a ballast bed (reference) are indicated as ΔL. A positive ΔL means higher noise emissions, and a negative ΔL means lower noise emissions. The differences in the share of superstructure in noise emissions are greater with vehicles with smooth wheels than with those with rough wheels, since here it is the rolling noise that is dominant.

The transfer functions in sonRAIL were measured in field tests and are compatible with TWINS calculations. The following superstructure types have been included in the web tool:

Superstructure with concrete sleepers

- Concrete sleepers, UIC54 rails in ballast bed ..... ΔL = -1 dB (with switches ΔL = 5 dB)
- **Concrete sleepers, UIC60 rails in ballast bed**..... ΔL = 0 dB (with switches ΔL = 6 dB)
- Concrete bi-block, UIC54 rails in ballast bed..... ΔL = 0 dB
- Concrete sleepers, UIC60 rails with absorbers ..... ΔL = -2 dB

Superstructure with steel sleepers

- Steel sleepers, UIC54 rails in ballast bed..... ΔL = 2 dB

Superstructure with timber sleepers

- Timber sleepers, UIC54 rails in ballast bed ..... ΔL = -2 dB (with switches ΔL = 7 dB)
- Timber sleepers, UIC60 rails in ballast bed ..... ΔL = 1 dB (with switches ΔL = 12 dB)

Indication of superstructure type is mandatory for calculation purposes.

4.2.3 Curvature (metres)

Noise emissions in track curves are influenced by a broad variety of parameters. In the same way as for a straight track, the influence of wheel and rail roughness, as well as superstructure type, has to be taken into account, plus the following additional influencing parameters: chassis construction, curve radius, super elevation, speed, slip angle, latitudinal and longitudinal force, striking of the flange against the rail head and the position of the axles. These factors and their complex interactions with respect to noise production can only be depicted in simplified form within a noise prediction model. Consequently, the emissions model focuses on the dominating factors of curvature, speed and vehicle type.

Curvature: optional parameter. Values ranging from 300 to 1,000 metres can be entered in the input field.

4.2.4 Types of bridges

Moving trains always produce higher levels of noise on bridges than on open routes, regardless of the track superstructure. In sonRAIL the influence of a superstructure type is depicted in the form of a specific transfer function, which describes the transfer from the mechanical excitation via the total roughness of wheel and rail to the reception point. The transfer functions of bridges differ from those of the various superstructure types on open routes in that the one-third octave levels are much higher in the low-frequency range between 100 and 2,000 Hz.

In order to obtain an impression of the noise emissions of a given type of bridge, the differences in the pass-by noise level of a vehicle with smooth wheels travelling at 80 km/h versus a reference track (concrete sleeper track with UIC60 rails in a ballast bed) are indicated as ΔL: A positive ΔL means higher noise emissions, and a negative ΔL means lower noise emissions. The differences in the share of superstructure in noise emissions are greater with vehicles with smooth wheels than with those with rough wheels, since here it is the rolling noise that is dominant.

The transfer functions in sonRAIL were measured in field tests and are compatible with TWINS calculations. The following superstructure types have been included in the web tool:

Concrete bridges

- Solid concrete slab with track in ballast bed ..... ΔL = 8 dB
- Solid concrete – hollow core slab with ballast ..... ΔL = 9 dB
- Reinforced concrete with track in ballast bed ..... ΔL = 8 dB

Steel bridges with timber sleepers

- Solid slab with track in ballast bed ..... ΔL = 12 dB
- Solid slab without ballast bed ..... ΔL = 18 dB
- Plate girder with track in ballast bed ..... ΔL = 12 dB
- Plate girder without ballast bed ..... ΔL = 25 dB
- Box girder with track in ballast bed ..... ΔL = 10 dB
- Box girder without ballast bed ..... ΔL = 16 dB
- Grid structure with track in ballast bed ..... ΔL = 6 dB
- Grid structure without ballast bed ..... ΔL = 19 dB

Reference superstructure

- Concrete sleepers, UIC60 rails in ballast bed ..... ΔL = 0 dB

4.2.5 Category

Selecting a category is mandatory. A (series) category is a pre-selection criterion for the series. This was introduced because the complete list of series is too complex. The number of selectable series is thus narrowed down when you switch from one category to another.

4.2.6 Series

The series (or vehicle type) is also a mandatory parameter. When you select a series, the two parameters, length and number of axles (see below) are automatically allocated a standard value that is defined in the database.

4.2.7 Length

The vehicle length is a mandatory input parameter and is allocated a default value based on the series. The default value can be modified manually in the input field.

> *Note: if you switch to another series, any manual adjustments that have been made will automatically be overwritten with the default value for the new series.*

4.2.8 Number of axles

Like the vehicle length, the number of axles is a mandatory input parameter and is allocated a default value based on the series. The default value can be modified manually in the input field.

> *Note: if you switch to another series, any manual adjustments that have been made will automatically be overwritten with the default value for the new series.*

4.2.9 Wheel flats

This is an optional parameter for calculating emissions. If the checkbox has been activated, wheel flats will be included in the calculation. In the vehicle calculation it is not possible to provide detailed information regarding the wheel flats.

4.2.10 Speed

This mandatory parameter indicates the speed at which the vehicle is moving. Please note that any inaccuracies in calculation are significantly magnified at low speeds (< 30 km/h).

4.3 Series details

Series Details
Link to Wikipedia: http://fr.wikipedia.org/wiki/SBB_Re_420
Re 420 Hersteller: SLM, BBC Familie: Einheitslok Bezeichnung: Re 4/4'' Vmax: 140 km/h Ursprungsmitglied von Fzg.-ID 2, unterdurchschnittliche Rollgeräuschabstrahlung wegen der Speichenräder, (spektrale Anpassung über Radrauheit) Valeurs de référence LpA_tot (7.5 m)*: 88.4 dB(A) * Les paramètres suivants ont été utilisés pour le calcul des valeurs de référence: Type de superstructure: Traverses en béton et rails UIC60 sur ballast Rugosité des rails: Moyenne Vitesse: 80 km/h
sonRAIL web tool version: 1.1.0.0

Figure 6: Series details

Here you will find a link to a Wikipedia page containing more detailed information about the series you have selected. If you click on the link, a corresponding help page will open in a new browser tab.

You will also find a brief explanatory text in the text field below the link.

4.4 Results (graph)

Once the calculation has been made, the results are displayed in the form of a graph as shown below.

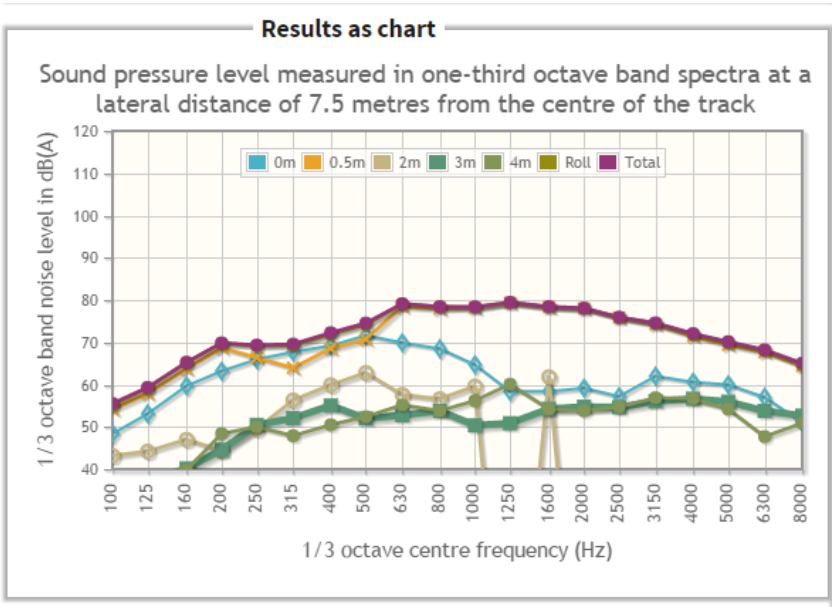


Figure 7: Results (graph)

The two scales of the graph are predefined and cannot be changed. The graph comprises 7 curves, which represent the one-third octave levels by one-third octave frequency for 5 source heights, plus rolling and total emissions.

You can hide a curve as desired by clicking on the corresponding entry in the curve.

4.5 Results (table)

To the right of the diagram the results are shown in table form.

Results table

Frequency	Sound pressure level measured in one-third octave band spectra at a lateral distance of 7.5 metres from the centre of the track						
	Spectrum of 5 source heights					Rolling noise	Total noise level
	LpAeq,T (0 m)	LpAeq,T (0.5m)	LpAeq,T (2m)	LpAeq,T (3m)	LpAeq,T (4m)	LpAeq,T (rolling)	LpAeq,T (tot)
100	48.4	54.2	43.2	36.9	34.4	55.2	55.5
125	53.1	57.9	44.2	37.3	35.5	59.2	59.3
160	59.7	63.8	47.0	40.2	39.8	65.2	65.3
200	63.2	68.7	44.4	44.6	48.4	69.8	69.9
250	66.0	66.4	49.5	50.5	50.0	69.2	69.3
315	67.7	64.0	56.3	52.1	47.9	69.3	69.6
400	69.2	68.6	59.9	55.1	50.5	71.9	72.3
500	71.6	70.7	62.8	52.0	52.4	74.2	74.6
630	69.9	78.5	57.6	52.8	55.2	79.1	79.1
800	68.5	77.9	56.6	53.8	53.8	78.4	78.5
1000	64.7	78.1	59.6	50.4	56.2	78.3	78.4
1250	58.4	79.4	-28.5	50.9	60.1	79.4	79.4
1600	58.4	78.3	61.8	54.3	54.2	78.3	78.5
2000	59.2	78.0	-28.0	54.8	53.8	78.0	78.1
2500	57.2	75.8	-28.0	54.7	54.7	75.9	76.0
3150	62.0	74.2	-27.9	56.1	56.9	74.5	74.6
4000	60.6	71.5	-28.3	56.7	56.7	71.8	72.1
5000	60.0	69.4	-28.6	56.0	54.2	69.9	70.2
6300	57.0	67.7	-28.8	53.8	47.7	68.0	68.2
8000	51.1	64.4	-30.3	52.7	50.9	64.6	65.1
LpAeq,T	**78.0**	**87.4**	**68.5**	**66.0**	**66.8**	**87.9**	**88.0**
% of total noise emissions	10.0	87.4	1.1	0.6	0.8	97.5	100.0

All noise emissions are indicated in dB(A)

Colour coding for uncertainty factor: Low Medium High Undefined

Copy Results to Clipboard

Figure 8: Results in table form (vehicle)

Note: in the table the degree of uncertainty that applies to a given value is identified on the basis of a colour code. For more information about uncertainties, please refer to section 7.

5 Railway route emissions

On the “Routes” page you can calculate the noise emissions for routes of railway. For this purpose the compositions of the trains have to be specified which use the route concerned.

For the individual compositions, modified train details can also be defined here.

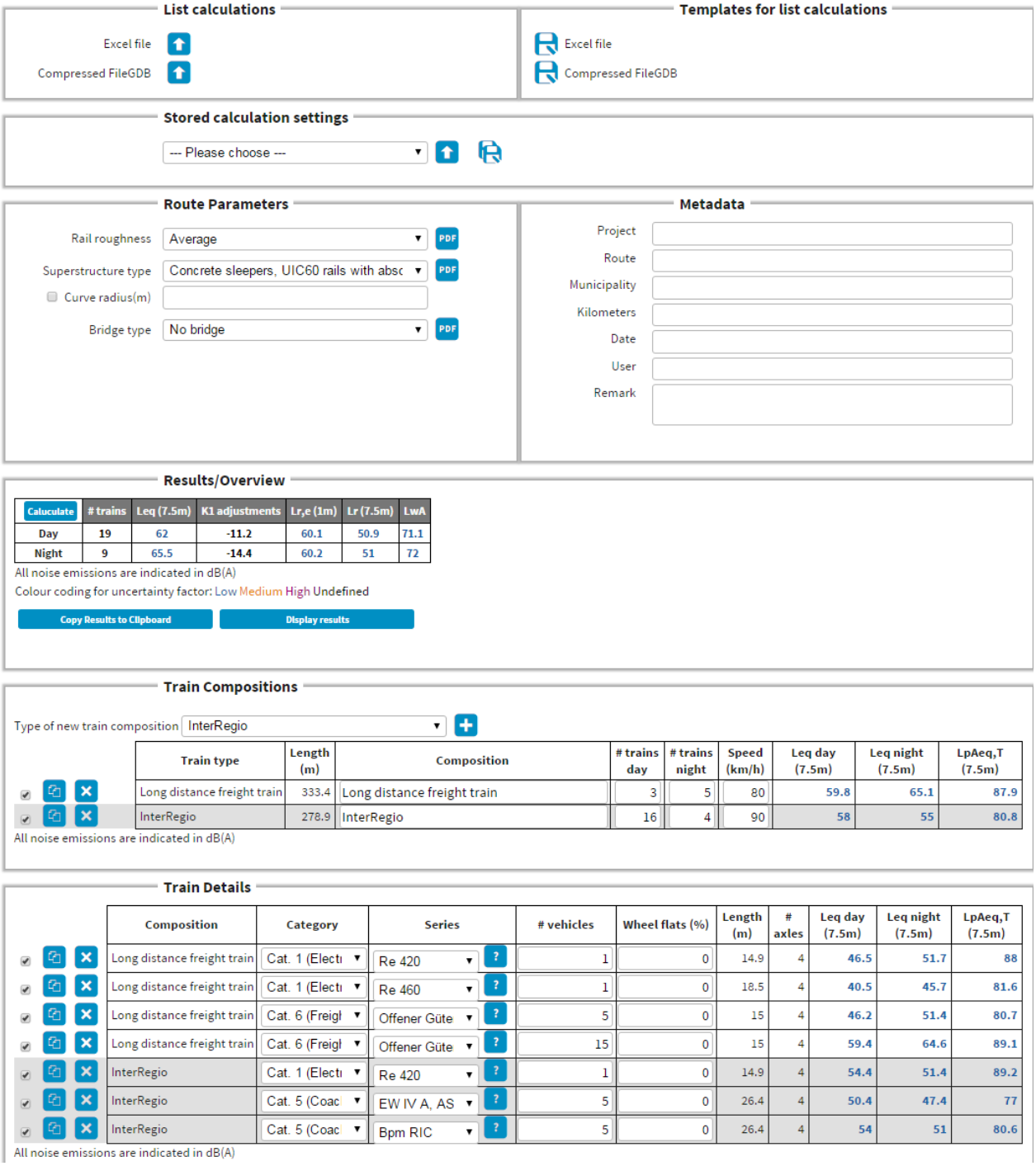

List calculations
Excel file
Compressed FileGDB
Templates for list calculations
Excel file
Compressed FileGDB
Stored calculation settings
--- Please choose ---
Route Parameters
Rail roughness
Average
Superstructure type
Concrete sleepers, UIC60 rails with absc
Curve radius(m)
Bridge type
No bridge
PDF
Metadata
Project
Route
Municipality
Kilometers
Date
User
Remark
Results/Overview
Calculate
trains
Leq (7.5m)
K1 adjustments
Lr,e (1m)
Lr (7.5m)
LwA
Day 19 62 -11.2 60.1 50.9 71.1
Night 9 65.5 -14.4 60.2 51 72
All noise emissions are indicated in dB(A)
Colour coding for uncertainty factor: Low Medium High Undefined
Copy Results to Clipboard
Display results
Train Compositions
Type of new train composition
InterRegio
Train type
Length (m)
Composition
trains day
trains night
Speed (km/h)
Leq day (7.5m)
Leq night (7.5m)
LpAeq,T (7.5m)
Long distance freight train 333.4 Long distance freight train 3 5 80 59.8 65.1 87.9
InterRegio 278.9 InterRegio 16 4 90 58 55 80.8
All noise emissions are indicated in dB(A)
Train Details
Composition
Category
Series
vehicles
Wheel flats (%)
Length (m)
axles
Leq day (7.5m)
Leq night (7.5m)
LpAeq,T (7.5m)
Long distance freight train Cat. 1 (Electi Re 420 1 0 14.9 4 46.5 51.7 88
Long distance freight train Cat. 1 (Electi Re 460 1 0 18.5 4 40.5 45.7 81.6
Long distance freight train Cat. 6 (Freigl Offener Güte 5 0 15 4 46.2 51.4 80.7
Long distance freight train Cat. 6 (Freigl Offener Güte 15 0 15 4 59.4 64.6 89.1
InterRegio Cat. 1 (Electi Re 420 1 0 14.9 4 54.4 51.4 89.2
InterRegio Cat. 5 (Coac EW IV A, AS 5 0 26.4 4 50.4 47.4 77
InterRegio Cat. 5 (Coac Bpm RIC 5 0 26.4 4 54 51 80.6
All noise emissions are indicated in dB(A)

Figure 9: Overview of the "Routes" page

5.1 List calculations / templates for list calculations

The list calculation function can be used for calculating the emissions on various routes in a single process. Templates are available for defining the route parameters and traffic data. The data can be defined in an Excel file or in a FileGDB using Esri ArcGIS as desired. The necessary templates can be downloaded via the icon in the "Templates for list calculation" section. Completed Excel files and zipped FileGDBs can be uploaded using the icon in the "List calculation" section. Calculations will be initiated automatically once the upload has been completed. When the calculations have been completed, an e-mail will be sent containing a link for downloading the results.

5.2 Stored route settings

This section contains functions for managing personal route calculations. The number of available functions depends on whether a stored calculation has been selected.

Figure 10: Managing route settings

The list contains stored personal route settings that are not visible for other users. New settings can be created, downloaded or uploaded, or deleted via the icons on the right.

With this icon, settings and results can be downloaded in Excel format.

This icon is for uploading settings saved in Excel format. The designation of the settings is the same as the name of the Excel file.

Use this icon for overwriting currently opened settings.

This icon is for saving current settings under a new name.
When you click on it, the following dialogue will appear.

After you have entered a name, please confirm it by clicking again on . To abort the process, click on “Cancel”.

Select this icon if you want to delete saved settings.

5.3 Railway route parameters

The following 4 parameters have to be defined here:

- Roughness of rails
- Superstructure type
- Curvature
- Bridge type

5.4 Metadata

Input of metadata is optional. Since these are adopted when they are copied to the clipboard, they can be useful for documenting your activities using sonRAIL.

5.5 Results / overview

The table shows the complete results of the calculation of emissions for the route concerned. The railway route parameters and active train compositions / train details are taken into account in the calculation.

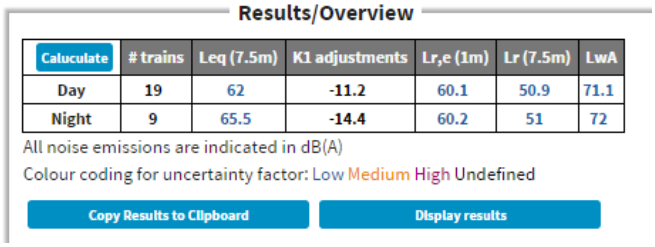


Figure 11: Results table

To start the calculation of emission levels, click on the “Calculate” button. The overall emissions, as well as the emissions from the train compositions / train details will be calculated.

In the results table the following data are displayed, separated according to daytime and nighttime:

- # trains = number of train compositions that pass through the route concerned during the specified time period.
- Leq (7.5m) = equivalent continuous sound level in db(A) at a distance of 7.5 metres from the track centre line.
- K1 adjustments = level adjustment for daytime and nighttime in accordance with Annex 4 of the Swiss Federal Noise Abatement Ordinance.
- Lr,e (1m) = Lr,e emission level for daytime and nighttime in accordance with Annex 4 of the Swiss Federal Noise Abatement Ordinance, at a distance of 1 metre from the track centre line.
- Lr (7.5m) = Lr emission level for daytime and nighttime in accordance with Annex 4 of the Swiss Federal Noise Abatement Ordinance, at a distance of 7.5 metres from the track centre line.
- LwA: Energy-equivalent mean acoustic power level for daytime and nighttime in accordance with the Swiss Federal Noise Abatement Ordinance.

Daytime refers to the period from 6 a.m. to 10 p.m., nighttime refers to the period from 10 p.m. to 6 a.m.

The “Copy Results to Clipboard” button can be used for copying the results and subsequently transferring them to another application, e.g. an Excel table (cf. section 4.6., “Copying results to the clipboard”).

5.6 Train composition

Train composition details are shown in the following table in the user interface:

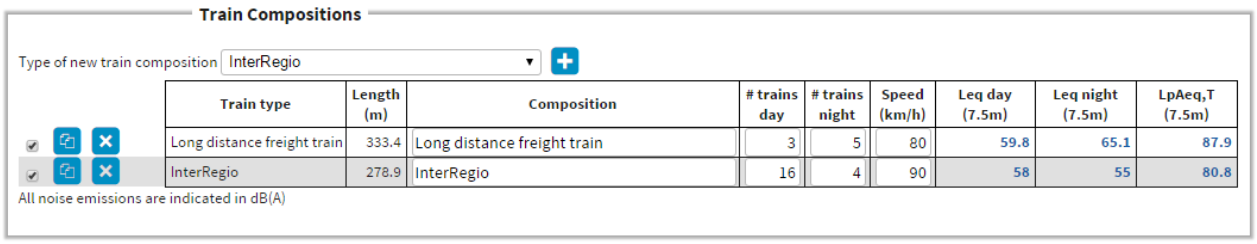

Train Compositions
Type of new train composition
InterRegio
Train type
Length (m)
Composition
trains day
trains night
Speed (km/h)
Leq day (7.5m)
Leq night (7.5m)
LpAeq,T (7.5m)
Long distance freight train 333.4 Long distance freight train 3 5 80 59.8 65.1 87.9
InterRegio 278.9 InterRegio 16 4 90 58 55 80.8
All noise emissions are indicated in dB(A)

Figure 12: Train compositions table

A new train composition can be added with the aid of the input field above the table. For this purpose, the first step is to select the corresponding train type from the list. The new train composition can then be added to the table by clicking on the icon. The attributes and train composition details will be allocated on the basis of default definitions, which can be edited in the table.

The table comprises the following columns:

- Icons:
  - The checkbox is for defining whether the train composition is to be included in the calculation
  - The "clone" is used for creating a duplicate of the composition concerned (including duplication of the train details)
  - The icon is for removing the composition, including the train details

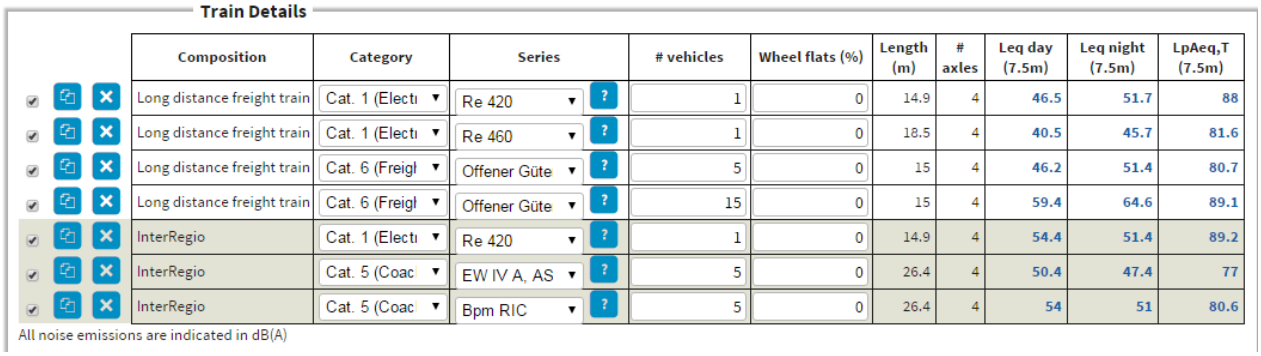
- Train type: The train type is defined when the composition is created and cannot be subsequently modified.
- Length: The length of the composition is calculated by adding the lengths of all train details in the composition.
- Composition: This field contains the name of the composition. By default, the name is the same as the train type. This should subsequently be changed, since the train details are identified on the basis of the name.
- # trains day: number of trains that travel along the route during the day.
- # trains night: number of trains that travel along the route during the night.
- Speed: speed in km/h at which the train composition travels along the route concerned.

Columns with noise level figures. These are completed by clicking on "Calculate". A colour code is used for indicating the degree of uncertainty of a displayed figure.

- Leq day (7.5m): equivalent continuous sound level of the train composition (daytime).
- Leq night (7.5m): equivalent continuous sound level of the train composition (nighttime).
- LpAeq,T tot (7.5m): total a-weighted equivalent sound pressure level during pass-by time (LpAeq,Tp).

All modifications other than change of name reset the results. In order to calculate emissions for a changed configuration you have to click on "Calculate results" (under "Results/overview") again.

5.7 Train details


Train Details

	Composition	Category	Series	# vehicles	Wheel flats (%)	Length (m)	# axles	Leq day (7.5m)	Leq night (7.5m)	LpAeq,T (7.5m)
	Long distance freight train	Cat. 1 (Electı	Re 420	1	0	14.9	4	46.5	51.7	88
	Long distance freight train	Cat. 1 (Electı	Re 460	1	0	18.5	4	40.5	45.7	81.6
	Long distance freight train	Cat. 6 (Freigl	Offener Güte	5	0	15	4	46.2	51.4	80.7
	Long distance freight train	Cat. 6 (Freigl	Offener Güte	15	0	15	4	59.4	64.6	89.1
	InterRegio	Cat. 1 (Electı	Re 420	1	0	14.9	4	54.4	51.4	89.2
	InterRegio	Cat. 5 (Coac	EW IV A, AS	5	0	26.4	4	50.4	47.4	77
	InterRegio	Cat. 5 (Coac	Bpm RIC	5	0	26.4	4	54	51	80.6

All noise emissions are indicated in dB(A)

Figure 13: Train details table

A train detail always belongs to a train composition, which is referenced on the basis of a key.

The table comprises the following columns:

- Icons:
  - The checkbox is for defining whether the train details are to be included in the calculation
  - The clone icon is used for creating a duplicate of the train details. This is automatically allocated to the same train composition.
  - The icon is for removing the train details from the composition.
- Composition: Name of train composition to which the detail belongs.
- Category: The list contains a selection of (series) categories. If you select a category, the list with the series that belongs to the selected category will be completed.
- Series: Defines the series of the train detail. After a series has been selected, the data in the “Length” and “No. of axles” columns will be automatically adapted. By clicking on the icon you can open a Wikipedia page containing detailed information about the series in a new browser tab.
- # vehicles: Indicates the number of train details included in the composition.
- Wheel flats (%): Indicates the degree of the wheel flats that have to be taken into account for the calculation of emissions.
- Length: Indicates the length of the series. In contrast to the “Vehicles” page, this cannot be modified here.
- # axles: Indicates the number of axles in the series. In contrast to the “Vehicles” page, this cannot be modified here.

Columns with noise level figures. These are completed by clicking on “Calculate”. A colour code is used for indicating the degree of uncertainty of a displayed figure.

- Leq day (7.5m): equivalent continuous sound level of the series (daytime).
- Leq night (7.5m): equivalent continuous sound level of the series (night time).
- LpAeq,T tot (7.5m): total a-weighted equivalent sound pressure level during pass-by time T.

All changes result in a reset of the calculated results. In order to calculate emissions for a changed configuration you have to click on “Calculate” (under “Results/overview”) again.

6 Administration

After logging in, under “Administration” you can manage your rail roughness parameters, superstructure types, bridge types, train details and train compositions.

The structure is as follows:

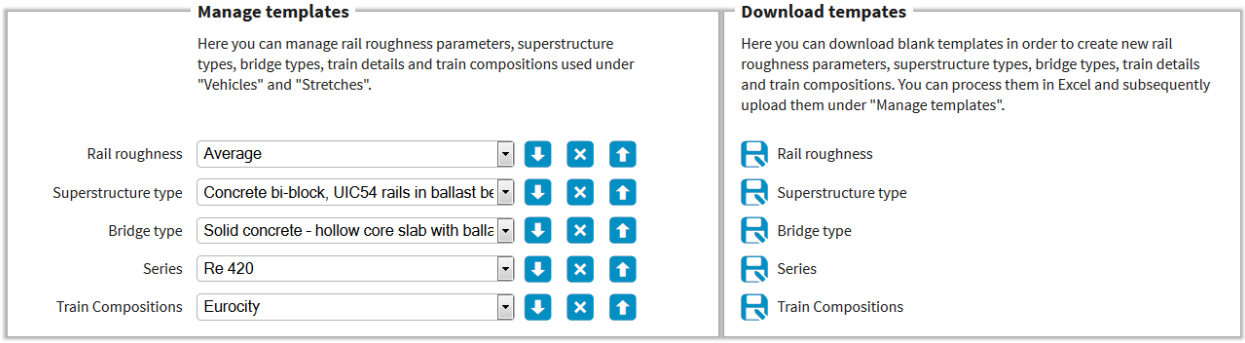

Manage templates
Here you can manage rail roughness parameters, superstructure types, bridge types, train details and train compositions used under "Vehicles" and "Stretches".
Rail roughness
Average
Superstructure type
Concrete bi-block, UIC54 rails in ballast be
Bridge type
Solid concrete - hollow core slab with balla
Series
Re 420
Train Compositions
Eurocity
Download tempates
Here you can download blank templates in order to create new rail roughness parameters, superstructure types, bridge types, train details and train compositions. You can process them in Excel and subsequently upload them under "Manage templates".
Rail roughness
Superstructure type
Bridge type
Series
Train Compositions

Figure 14: Overview of the “Administration” page

On the left you will find the functions for downloading existing definitions and managing your own templates. On the right you will find blank Excel templates for defining your own new ones.

6.1 Manage templates

This icon is for downloading settings in Excel format. These settings can be used as the basis for creating new templates.

With this icon you can upload settings saved in Excel. Designations and display names must be unique.

This icon can be used for deleting your own stored settings.

6.2 Download templates

In addition to downloading existing rail roughness parameters, superstructure types, bridge types, train details and train compositions, via the icon you can also download blank Excel templates that you can use for creating new ones of your own. The disadvantage of this option is that no own train details are available for train compositions.

7 Indication of uncertainty factors in sonRAIL

1. Every sub-source in the emissions database (Tables 0001_sec_source_option2.2.xlsx and 0001_sec_source_option3.1.xlsx) is allocated to one of the following four categories for the purpose of evaluating data quality:
   a) Accurate measurement
   b) Accurate calculation (e.g. with TWINS)
   c) Measurement with incomplete or supplemented data or some unknown variables
   d) Projection
2. These four categories are linked to an assessment of the degree of uncertainty of the emissions data. The following values are proposed as standard deviation:
   a) Accurate measurement: 0.5 dB(A)
   b) Accurate calculation: 1.0 dB(A)
   c) Measurement of reduced quality: 2.0 dB(A)
   d) Projection: 3.0 dB(A)

   The indication of accuracy for category a) corresponds to the criteria for the emissions data as they were formulated in the sonRAIL project. The other figures are estimates.
3. The above uncertainty factor estimates are based on assumptions. In view of this, users should note the following restrictions: "The indication of accuracy only represents the uncertainty of the emissions data in combination with the sonRAIL emissions model during travel on open routes. Errors and inaccuracies in the modelling procedure, e.g. in the event of unknown rail roughness, are not depicted. Higher degrees of uncertainty have to be anticipated with regard to switches, bridges and curves."
4. The contribution to the pass-by noise level at a distance of 7.5 metres and to the rating level at a distance of 1 metre is calculated in dB(A) from each of the five sub-sources per vehicle.
5. The uncertainty factors for the 7.5-metre pass-by level and the 1-metre rating level are calculated from the contributions from the five sub-sources per vehicle using the following formula:

$$s = \frac{\sqrt{\sum (s_n \cdot 10^{0.1 \cdot L_n})^2}}{\sum 10^{0.1 \cdot L_n}}$$

   Here, s is the standard deviation of the energetic sum L_n = the totalled levels and s_n = the respective standard deviations. [Source: W. Probst & U. Donner: Die Unsicherheit des Beurteilungspegels bei der Immissionsprognose. *Zeitschrift für Lärmbekämpfung*, vol. 49 no. 3) May 2002)].
6. Using the same formula, the uncertainty factor for entire trains – and in an additional step, for entire routes – can be calculated.
7. In sonRAIL, the resulting standard deviations are displayed with the aid of a colour code instead of in the form of figures:
   a) $s \leq 1$ dB(A) Blue
   b) $1 < s \leq 2$ dB(A) Orange
   c) $2 < s$ Purple